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The Application of Aerial Photo-Topographic Methods to Highway Location

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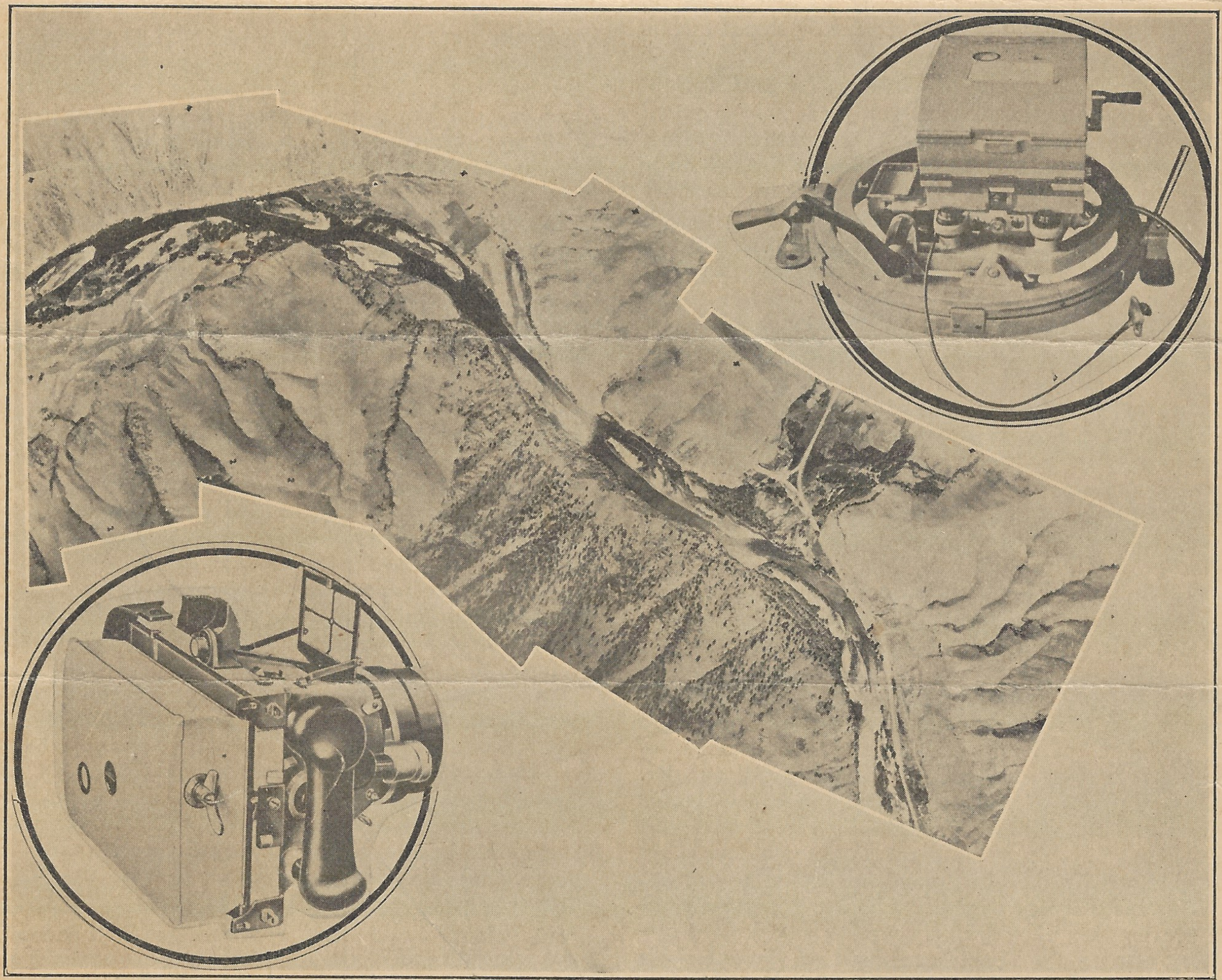

Upper Right—Automatic Aerial Surveying Camera. *Center*—Mosaic of Salmon River, Idaho—Norfolk, Idaho.
Lower Left—Hand-operated Aerial Surveying Camera.

With the constant and increasing demand for better and safer highways has come the need for better location with respect to alignment and gradient. Combined with this need are also those economic factors which influence the placement of the road in relation to habitations. To visualize and attempt to comprehend the vast network of highway lines which are now beginning to cover most of the states is next to impossible.

The field engineer on location work is only able to cover a width of several hundred feet parallel to his projected line. It is very possible that many other

locations are equally as good and probably in a better position, but he cannot delay the work to search out and investigate all these routes. At the completion of his projected location he may have all the data desirable and essential to prove the justification for his chosen route, but unfortunately he is not able to place in his superior officers' hands such data as will substantiate his beliefs, nor can he furnish such data as will permit some one person who has never been on the ground to study and independently determine the most feasible location. A mere office study of field notes fails to create any comprehension of relative routes. The one and only way that this can be done is to view the entire route from an airplane, and even this method has many drawbacks, the major one being the speed of travel, which allows no time whatsoever for anything other than a cursory examination of the proposed routes. Another drawback is, that due to the necessity for flying at a safe altitude, the relief of the country is so greatly flattened that no knowledge regarding relative grades or slopes can be obtained.

The application of aerial photography to this problem permits a detailed office study of each proposed route. Such photographs are taken vertically from the bottom of a plane and are on any desired scale dependent upon the altitude of flight. It is customary to take these photographs at intervals which permit an overlap of at least fifty or sixty per cent between adjoining pictures. This permits the overlapping area, which has actually been photographed twice from different positions in the air, to be viewed stereoscopically.

We can all recall the parlor stereoscope with its photographs of the activities of the Spanish-American War, China during the Boxer Rebellion, etc. Remember how two photographs, pasted side by side on a card mount, blended together when viewed through the two eyepieces of the stereoscope, and how objects stood out and appeared as they do in nature. This same principle has now been brought to scientific use, and instruments have been constructed where it is possible to actually make accurate topographic maps by stereoscopic methods. Contours can be traced out on the stereoscopic models derived by viewing overlapping aerial photographs, and can be transferred to a map board precisely where they belong; man-made objects, such as houses, roads, and trails can be accurately portrayed in their relative positions; the many windings of waterways and the sinuosities of rivers and streams can be faithfully reproduced with a degree of accuracy far greater than could possibly be obtained by the old ground method of surveying.

The executive or engineer who has a complete set of overlapping photographs covering any desired territory can, by the simple expedient of viewing these pictures stereoscopically, transfer himself figuratively out into the field and be poised over the particular area in which he is interested. In this manner he is free to devote an unlimited amount of time to the territory under consideration and the study of particular areas is restricted only by his own desires.

In addition to the advantages that aerial photography offers in a study of the proper location of highways, it is also possible by the use of specially constructed instruments to make topographic maps, provided that the photography is undertaken with special mapping cameras.

During the past summer one of the western states employed the Aerotopograph Corporation of Washington, D. C., to fly and photograph more than six hundred linear miles of proposed highway locations. A large portion of this work followed major rivers, which headed against the Rocky Mountains. For years the state had endeavored to secure a connection between two cities on opposite sides of these mountains, a distance of practically one hundred and sixty miles. Three alternative routes presented themselves, but to survey each route independently by the old ground methods would not only cost an enormous amount of money, but would consume from three to five years' time. The photographic work on these three routes consumed seven hours' flying time. Within thirty days the State had been furnished with complete sets of all the photographs. These photographs were carefully studied under the stereoscope by a consulting engineer of national reputation on railroad location work who had been especially retained for this purpose. After he had completed his study and had marked his proposed location on the prints, the data were transferred to an assembled mosaic. A conference of federal and state representatives was held, and after studying the data acquired from the photographs, which included the length of each line, its construction difficulties, the location and number of necessary bridges, etc., one route was chosen as far more feasible and possibly more economical to construct.

After the route was chosen, a ground survey party was sent to the field to establish the small amount of control essential to construct a topographic map. A traverse and level line was carried down the river, securing horizontal location and vertical position of a few picture points which could be readily identified in the photographs and located on the ground. As soon as the ground work was completed, which, incidentally, required thirty-two days to control fifty-two and a half linear miles, the preparation of a topographic map on the scale of five hundred feet to the inch with ten foot contours was commenced. The topographic strip averaged from one thousand to two thousand feet in width. On this map the State Highway Commission has made its projected location, and has prepared a preliminary estimate of the cost, based on these data and on information secured by the ground party pertaining to soil classification, etc. Sufficient points were perpetuated in the field to make it possible to initiate preliminary locations therefrom or tie them thereto as a check.

It has been estimated that the survey of this one route alone would have required one full season's work, would have cost considerably more and the resulting topographic strip would have only been several hundred feet wide.

In addition to the uses enumerated above, aerial photographs are being used more and more in a study of existing highways, principally to determine (1) the rate of traffic flow; (2) the relocation of existing roads; (3) the location of "bottle necks" which retard the even flow of traffic; and (4) the exact locations and outer boundaries of rights of way.

During the summer of 1927, the State Roads Com-

mission of Maryland had an aerial traffic survey made of the road between Baltimore and Washington. The route was flown at an altitude of about three thousand six hundred feet, and the resulting photographs were on the approximate scale of three hundred feet per inch. These were subsequently enlarged to a scale of about one hundred feet per inch. The distance flown and photographed was about thirty miles. Each photograph overlapped the succeeding one about fifty per cent. The photographing was done on a holiday and at an hour when it was likely that the traffic would be heaviest. Six Highway Department cars were fitted with white tops by stretching sheets over them, on each of which was painted a number. These "spot cars," as they were called, were timed to enter traffic on the road so as to be photographed at various points. The drivers were instructed to travel with traffic, not to attempt to pass slow traffic, and not to hold up traffic.

From a careful and analytical study of the resulting photographs it was possible to discover many unsuspected elements retrogressive to the smooth, uninterrupted flow of traffic. Similar studies on many congested highways will be of material assistance in determining the corrective factors necessary to secure a smooth traffic flow. A very simple analogy is the comparison between a clogged watermain and a congested highway. By the simple and usually economical cleaning out of the system, possibly removing many bends where sediment settles, the system is able to carry much more water (traffic) by securing a more even and uniform flow.

During the past summer further work was done for the Maryland State Roads Commission in photographing additional mileage of principal highways. The resulting photographs were used in office studies to determine the exact location of rights of way and in planning improvements in alignment by eliminating excessive curvature. The width of terrain shown in each photograph permits a much more comprehensive study of possibilities than is ever attainable by ground surveys. The exact forest cover, whether it be heavy timber or merely underbrush, is readily discernible and accurate estimates of clearing costs can be determined.

In rights of way studies, the final location of the outer boundaries can be determined with relation to property lines, buildings, etc., before the property owners have become aware that any rights of way purchases are proposed. No field parties projecting preliminary locations ever appear on the ground, and the owner is not even aware of any proposed construction work until he is approached regarding the purchase of the right of way. In many cases this one phase alone has resulted in a saving in right of way costs which in itself has more than paid for the aerial survey.

The uses to which aerial photography can be put in assisting in the solution of all problems wherein the physiography of the earth is concerned are innumerable.

Young Wife: "Aren't you the same man I gave some biscuits to last week?"

Tramp: "No, mum, and the doctor says I never will be again."

ELECTRICAL EYES

Television

PART I

One original invention is credited to Nipkow, a German; fifty years ago he explained scanning, line after line with a spot light, the object of which an image was to be made visible at a distance. He lacked several essentials, particularly amplifiers and other devices made familiar since then through radio.

How far can a picture be "televised?" Experimenters of General Electric Company sent television waves from Schenectady, New York, to Australia and had them come back. After traveling 20,000 miles a rectangle still had four corners, although broken into pieces most of the time.

In 1927 a picture three inches square on the screen was achieved by Alexanderson; in the fall of 1929, a picture fourteen inches square, not simply black and white like a silhouette; all the gray shades were reproduced, registering every shadow and giving depth and detail. In May, 1930, television first appeared as part of a regular performance at a theatre. It was in Schenectady, and the image was six feet square.

Antenna radiation is modulated by a succession of impulses supplied by the beam of light scanning the object of which a picture is being transmitted. The subject stands before an incandescent lamp. Between subject and light is a metal disc the size of a bicycle wheel, drilled with forty-eight holes. The revolving disc covers the complete subject twenty times per second; that is, there are twenty complete pictures made up of light and shade. A frame contains four photo-electirc tubes, sensitive to light. The tubes respond 40,000 times per second to impulses reflected back from the subject.

At the receiver the electrical impulses are passed on to a light valve, in the middle of an intricate lens system, in front of a high-intensity arc lamp similar to those used for projection of motion pictures. The light valve operates delicately and accurately to permit passage of light in correspondence to impulses received from the television transmitter. These light emissions are passed to a rotating disc supporting lenses in places corresponding to the holes of the disc at the originating point. Additional lenses pass the light forward to the screen, where these light impulses, at the rate of 40,000 per second, become the living, active image.

Based on information supplied by E. F. W. Alexanderson, Sc.D., General Electric Laboratories, Schenectady, New York.

(Continued on page seven)

THE UTAH ENGINEER

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SPEAKING OF TAXES

We are always sure of taxes. We recognize the fact that taxes are necessary to maintain our government, but we are not unmindful of the fact that taxes may become burdensome. In fact promiscuous application and increase of taxes may actually stifle our industrial development, and cause a decline of our communities. The happy situation, of course, is to know just how far to go, and at the same time, provide encouragement to new industries. Instead of increasing taxes our attention should be centered on increasing taxable resources and then the tax revenue will take care of itself. If our taxable resources remain constant, increased taxation is obvious with increased cost of government and the consequent added burden is a deterrent to growth.

Utah and her sister states are clamoring for more revenue, and as a result some rather interesting legislation has come from our recent legislatures. Nevada and Idaho vie with each other for divorce business. Nevada reverts to the old days of the frontier and again legalizes gambling, because of its revenue to the state coffers. Idaho puts a tax on the generation of power within her boundaries. This, of course, is a tax which the Utilities Commissions will doubtless permit to be added to electric rates.

Why not find some way of bringing money into Utah and encourage some state growth?

Encouraging industries to locate here, and thereby increasing our taxable property is the most consistent solution of the tax problem.

SAFETY FIRST CAMPAIGN SHOWS RESULTS

During 1930 ten states conducted Save-A-Life motor vehicle inspection campaigns. Close to 3,500,000 cars were examined as to brakes, lights, horns, steering mechanisms and the like. More than a million of these had defective brakes, 2,000,000 had unsafe headlights, 219,000 had defective steering, and thousands more had other defects of smaller importance. The faulty equipment was corrected, with the result that during the month in which the campaigns took place and the month following, most of the states enjoyed a decrease in accidents.

The value of inspections, like the value of laws requiring examination of drivers, is not open to doubt. There is every reason to believe that a large proportion of automobiles using the highways are defective, and that brakes, steering or lights might fail in an emergency.

It may be that the most hopeful sign in the automobile accident firmament at present is the vast amount of scientific attention being given the problem. The entire nation is observing those states which, in spite of a rising national accident record, are reducing fatalities and injuries. The near future should bring us a long way toward solving the highway accident problem.

IMPORTANT TO THE PUBLIC

Only by strict curtailment of production can the domestic copper producers re-establish themselves on a sound, profitable basis.

These producers are now seeking to put such a program into general effect. American copper stocks have been constantly rising, and last year the structure toppled of its own weight and prices dropped to the lowest point in decades.

There is more to the present situation than whether or not the copper companies and their investors make or lose money. Copper is a basic American industry, furnishing livelihood to thousands of citizens. The financial strength and industrial progress of several states is inextricably interwoven with copper. As in the case of overproduction of farm crops, the effort to adjust copper demand and supply, and eliminate surplus stocks, is a progressive move that deserves national support.

FACTORY PRODUCTION OF HOUSES SUGGESTED

Mr. Grosvenor Atterbury, New York architect, says that "Under the existing antiquated building methods, mechanics at $12 and $15 a day can never produce a small house that is worth the money it costs. It is a poor buy even if the laboring man has the money to pay for it. Even at cost, it is poor value compared with food and clothing—and many of his luxuries. The rich man, perhaps, could afford to pay for the waste included in the price. The poor man most certainly cannot and it is doing him a questionable service to help finance such a purchase."

"A national building council recently disclosed the fact that the average house built today has a useful life of but 12 years—that after 12 short years, it will no longer be habitated—or can be made so only by unreasonably expensive repairs."

The electrification of farms in the United States has grown from 166,140 in 1923 to 647,677 as of December 31, 1930. Last year, 90,806 farms were electrified, an increase of 16.3%.

Incidents now point to the probability of an appeal to the Federal Government to finance the $200,000,000 aqueduct for Los Angeles. Some folks admire the courage (?) of Los Angeles.

EXPERIENCE SPEAKING

"In time of trial," inquired the speaker, "what brings us the greatest comfort?"

"An acquittal," interrupted a man at the back of the hall.—*Christian Evangelist.*

ENGINEERS' WEEK AT THE UNIVERSITY OF UTAH

ENGINEERS' WEEK is now an established institution at the University of Utah. It is sponsored by the Engineering Society, (made up of undergraduate students in engineering), by the engineering faculty, and by the university authorities.

This year, Engineers' Week was from April 6th to April 11th. The engineering laboratories were open to the public to permit their inspection by visiting engineers, as well as all others visiting the university campus during the week. All the laboratories were in operation at the time so that visitors might acquaint themselves, not only with the extent to which the engineering school of the university is provided with laboratories and equipment, but likewise the nature of the work which is carried on in these laboratories. Guides were provided for the convenience of visitors and all the members of the several engineering societies of the state were invited to visit the university during the week.

The outstanding feature of the week was a lecture by Dr. H. T. Plumb, consulting engineer for the General Electric Company in the intermountain district. The lecture was preceded by a dinner at which the engineering students were hosts to the professional engineers of the state. Among the guests of honor were Governor George H. Dern, (a mining engineer), the Secretary of State, the Mayor of Salt Lake City, and the members of the Board of Regents of the University of Utah. After the dinner the guests and members of the various engineering societies present assembled in Kingsbury Hall to hear Dr. Plumb's lecture and to witness a demonstration of high frequency and high voltage currents, artificial thunder and lightning, corona discharges and effects, the photo-electric cell, and the art of painting with electricity and light. Dr. Plumb has gained an enviable reputation throughout the intermountain west because of his scientific lectures. Every year he speaks before more than fifty thousand people in his tours, which take him to every town of importance in the surrounding five states. He is a graduate of Milton college and the University of Wisconsin, and for many years was professor of electrical engineering at Purdue University. He is recognized as an authority on engineering matters, especially scientific illumination, and is well deserving of his enviable record as a speaker because of the unique and happy faculty he possesses of "putting over" difficult subjects in a popular and entertaining manner.

Among other features of the celebration was the editing of a feature "Engineers' Edition" of the student newspaper; illuminating the campus and all buildings with colored lamps and floodlights. An interesting parade, made up of unique floats, was staged in the downtown section of the city and was followed by the traditional initiation of all graduating senior engineers into the "Ancient and Honorable Order of Saint Patrick" as the concluding event of the celebration. During the week, the Queen of the Engineers presided over these happenings in a regal manner.

Telephone Operator: "It costs seventy-five cents to talk to Bloomfield."

Scotchman: "Can't you make a special rate for just listening? I want to call up my wife."

ENGINEERING LIBRARY NOTES

(University of Utah)

The following publications have been received in the Engineering Library since March 1, 1931:

List of Books

Crowell & Murray—Iron ores of Lake Superior. 6th edition. 1927.

U. S. Bureau of Reclamation—Dams and control works. 1929.

Loew, E. A.—Electrical power transmission. 1928.

Thews, E. R.—Metallurgy of white metal scrap and residues. 1930.

Ware, John C.—Chemistry of the colloidal state. 1930.

Smith, D. C.—Visual lines for spectrum analysis. 1928.

Lindsley, L. C.—Industrial microscopy. 1929.

Peele, Robert—Compressed air plant. 5th edition, largely rewritten. 1930.

American Electrochemical Society. Transactions, vol. 58, 1930.

Woldman, N. E.—Physical metallurgy laboratory manual. 1930.

U. S. BUREAU OF MINES PUBLICATIONS

Econ. paper—Economic paper
I. C.—Information circular
R. I.—Reports of investigations
T. P.—Technical paper

Bibliography of U. S. Bureau of Mines investigations on coal and its products, 1910-1930. A. C. Fieldner and M. W. von Bernewitz. T. P. No. 493.

Economics of crushed-stone production. O. Bowles. Econ. paper, No. 12.

Economics of strip coal mining. O. E. Kiessling, F. G. Tryon and L. Mann. Econ. paper, No. 11.

Platinum. P. M. Tyler and R. M. Santmyers. I. C. No. 6389.

Dictomite. P. Hatmaker. I. C. No. 6391.

Milling methods at the Hurley plant of the Nevada Consolidated Copper Co., Hurley, N. Mex. Fred Hodges. I. C. No. 6394.

Mining methods of the Ducktown Chemical & Iron Co., Mary Mine, Isabella, Tenn. V. L. Kegler. I. C. No. 6397.

Directory of Utah Engineering Organizations

ENGINEERING COUNCIL OF UTAH

H. C. Goodrich................President
Kearns Building, Salt Lake City

Geo. M. Bacon................Secretary-Treasurer
State Capitol, Salt Lake City

MEMBER SOCIETIES

Utah Society of Engineers
H. C. Goodrich................*President*
Ralf R. Woolley................*Secretary*
313 Federal Bldg., Salt Lake City.
Meetings third Wednesday of each month except July and August.

Utah Section of the American Institute of Electrical Engineers
L. B. Fuller................*Chairman*
Paul Ransom................*Secretary*
Utah Apex Mining Company
Bingham Canyon, Utah
Meetings subjects to call.

The American Institute of Architects, Utah Chapter
Raymond J. Ashton................*President*
Lorenzo S. Young................*Secretary*
Continental Bk. Bldg., Salt Lake City

Utah Section of the American Institute of Mining and Metallurgical Engineers
J. A. Norden................*Chairman*
C. T. Van Winkle................*Secretary*
319 Dooly Bldg., Salt Lake City
Meetings second Thursday of each month except June, July, August and September.

Utah Section of the American Society of Mechanical Engineers
Arthur Erickson................*President*
William J. Cope................*Secretary*
University of Utah
Salt Lake City
Meetings subject to call.

Utah Section of the American Society of Civil Engineers
C. E. Painter................*President*
A. B. Purton................*Secretary*
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Meetings subject to call.

Ogden Engineers Club
Successor to
Ogden Chapter American Association of Engineers
J. R. Jarvis................*President*
F. W. Earl................*Secretary*
521 Eccles Bldg., Ogden, Utah

Construction of the Wachusett-Coldbrook tunnels. D. C. Corner. I. C. No. 6399.

Mining methods and costs at the Spring Hill Mine, Montana Mines Corp., Helena, Montana. A. L. Pierce. I. C. No. 6402.

Magnesium compounds (other than magesite). P. M. Tyler. I. C. No. 6406.

Milling methods and costs at the Homestake Mine, Lead, S. Dak. A. J. Clark. I. C. No. 6408.

Mining by the top-slicing method, with some notes on sublevel caving. C. F. Jackson. I. C. No. 6410.

Method and cost of recovering quicksilver from low-grade ore at the reduction plant of the sulphur bank syndicate, Clearlake, Calif. W. Bradley. I. C. 6429.

Effect on workers of air conditions. R. R. Sayers. I. C. No. 6439.

Resistivity measurements upon artificial beds. J. H. Swartz. I. C. No. 6445.

Geophysical abstracts, No. 22. F. W. Lee. I. C. No. 6452.

Leaching copper ores: advantages of wet-charging. J. D. Sullivan and A. P. Towne. R. I. No. 3050.

A device for determining work input to a laboratory ball mill. John Gross and S. R. Zimmerley. R. I. No. 3056.

The production of high-manganese slag in the electric furnace. T. L. Joseph, C. E. Wood and E. P. Barrett. R. I. No. 3080.

New manganese-silicon alloys for the deoxidation of steel. C. H. Herty, Jr., and G. R. Fitterer. R. I. No. 3081.

Coal mine fatalities in Jan., 1931. W. W. Adams and L. Chenoweth. R. I. No. 3090.

Separation and size distribution of microscopic particles. P. S. Roller. T. P. No. 490.

Coal-mine safety organizations in Alabama. R. D. Currie. T. P. No. 489.

Deoxidation of steel with silicon. C. H. Herty, Jr., G. R. Fitterer, and C. F. Christopher. T. P. No. 492.

Copper and zinc in cyanidation sulphide-acid precipitation. E. S. Leaver and J. A. Woolf. T. P. No. 494.

Be sure to attend the Engineers' Luncheon at the Chamber of Commerce every Monday at 12:15

ELECTRICAL EYES

(Continued from page three)

Part II

April 7, 1927, one-way systems for television over telephone circuits by radio were demonstrated in Bell Telephone Laboratories, New York, permitting an individual to see as well as to hear a person in Washington. On a large television screen the audience observed the person at Washington while hearing his words over the loud-speaker. This receiver was used also to demonstrate television by radio, at which time there was presented to an audience the first radio broadcasting program of sound and scene.

With photoelectric cells of greater sensitivity it became possible, in July, 1928, to illumine the subject broadly by daylight, and allow the photoelectric cell to "behold" only one small area of the picture at a time. This "direct scanning" lends itself particularly to action at a distance from the lens. Improvement of photoelectric cells sensitive at the red end of the spectrum, and glow-discharge tubes whose light is rich in blue and green rays, made possible in June, 1929, an image in color, using beam-scanning and superposing three one-color images.

Experimental two-way television service between American Telephone and Telegraph Company building at 195 Broadway and Bell Telephone Laboratories at 463 West Street, nearly two miles apart, was demonstrated to representatives of the press on April 9, 1930. Special telephone booths were equipped with television transmitters and receivers, designed by the Laboratories. A person seats himself in a booth before a frame in which he will see the face of the person with whom he is talking. His own face is rapidly scanned by a mild beam of blue light which reflects from his face to the photoelectric cells and gives rise to the current which transmits his image. There is no fierce glare to the scanning beam; one is not annoyed by its presence and may even gaze directly at it without inconvenience.

The first thing that strikes the observer when he steps into the booth, lighted with a dim orange light to which the photoelectric cells are insensitive, is the absence of the usual telephone. Special telephone transmitters and receivers are concealed in the booths. One talks face to face to the distant person and a hidden receiver speaks the words, which seem to issue from his mouth. An ordinary telephone is not used because it would hide part of the speaker's face. This novel arrangement adds naturalness to the conversation. The other party appears with sufficient detail for recognition of facial expression but the effect is like looking at an animated cabinet-size photograph, because the image is produced in monochrome. What one sees is like an instantaneous moving picture done in black on a pink background due to the color of the neon tube, whose flashing light through the synchronized scanning disc forms the image.

Based on information supplied by Herbert E. Ives, Ph. D., Bell Telephone Laboratories, New York City.

References for further reading: "Symposium on Television," Bell System Technical Journal, October, 1927.

"Direct Scanning in Television," Journal of the Optical Society, December 1928.

"Television in Colors," Journal of the Optical Society, January 1930.

"Two-way Television," Bell System Technical Journal, October 1930.

STEAM-DRIVEN BUSES TO BE GIVEN TRIALS

New Zealand Promoters Offer New Passenger Vehicle

Steam-propelled buses, believed by their New Zealand promoters to offer a possible substitute for the gasoline-driven type now in use in Auckland, will shortly be given trials under passenger service conditions in that city, states an article in the New Zealand Herald, according to Consul Walter F. Boyle, Auckland.

Outwardly the bus will differ very little from those now in use but it is claimed that the quiet running and smooth, silent acceleration will distinguish it from other vehicles.

The boiler, consisting of a series of coiled tubes, has been placed in the space previously occupied by the gasoline motor, and a condenser to return the exhaust steam to water for renewing the boiler supply has been placed in the position of the radiator giving the same appearance as formerly. The engine is under the floor of the bus just in front of the rear axle and thus doing away with the loft drive shaft, and the cylinders are packed and encased to prevent the escape of heat. Speed is governed by a throttle wheel within the steering wheel which can be operated by the thumb, it is said. Reversing is done by means of a foot pedal, there being no gear shift lever and no clutch pedal.

BUILDINGS, LIKE PEOPLE, NEED "VEINS" FOR LIVING

The adequacy of "veins" not only determines the longevity of the human body, but also the life of buildings, according to architects who designed the new New York hospital in New York City.

They say that many buildings, while still sound, become obsolete because of the inadequacy and the inaccessibility of its "veins"—the lines which carry gas, electricity and water. In the new hospital all pipes and wires are designed for double the immediate requirements.